$\frac{\text{Energy}}{\text{Momentum}}$ from 15 GeV

Isolated Single Track Trigger

CDF Simulation Meeting

Shawn Kwang
with
Soon Yung Jun and Mel Shochet

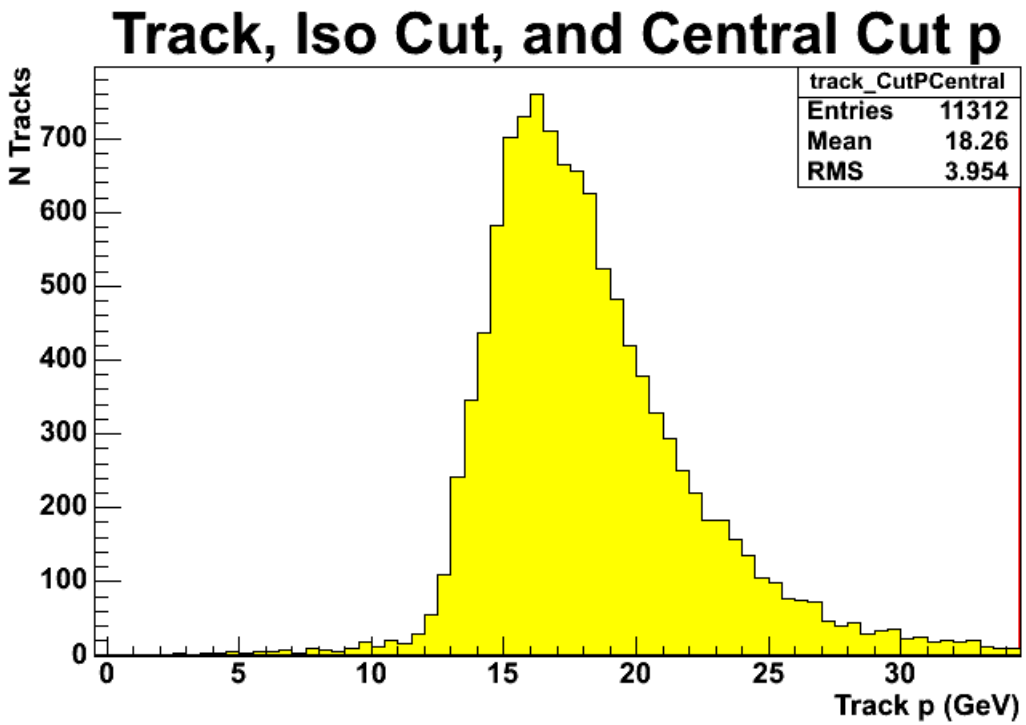
Introduction and Outline

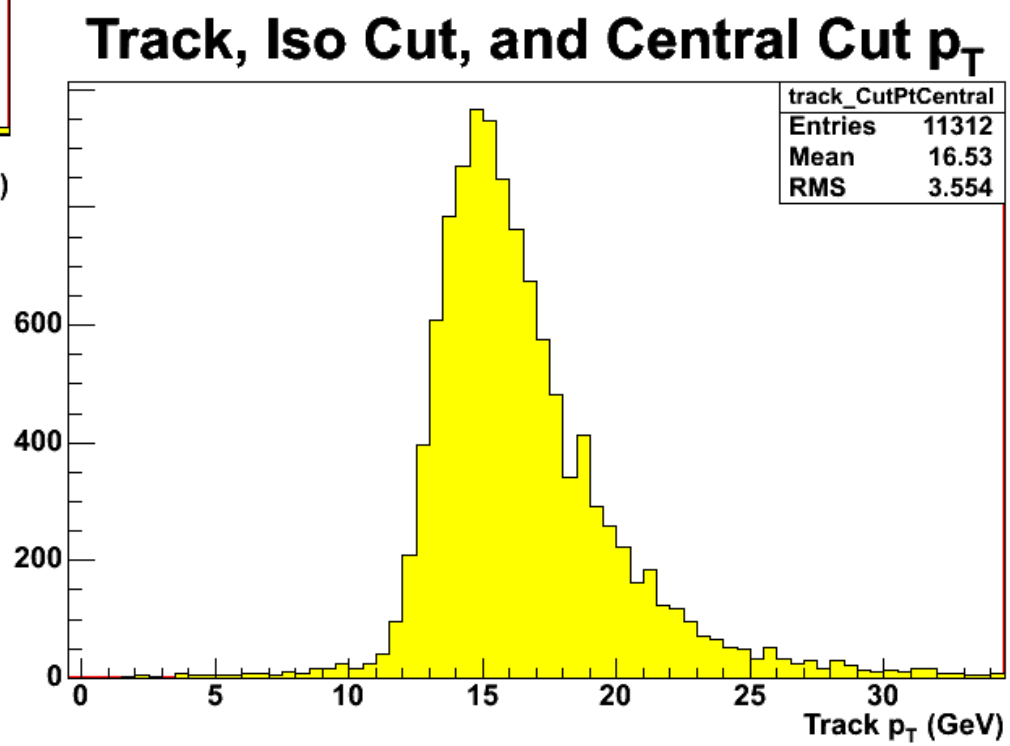
- Motivation: Measuring the response of the central calorimeter to single particle/isolated tracks with high momentum
- Dataset taken over summer
- Isolated track selection
- Fake tracks generated
- Comparison of Energy/Momentum of high P tracks
- Results
- Conclusions

Data used in this study

- Track data taken this summer.
  - Used a single track trigger to collect high momentum isolated tracks
  - Dataset: gjtc0h_stt15
    - Processed 1/3 of data with Stntuple 6.1.2 (Total approx. 2 million events)
- Trigger JET15_CAL_TRK15_DO_L2ISO
  - Lum. enabled at 40E30 cm^2/s
  - Level 1 : L1_TAU0_TRK10_LUMI_0_40_v-1
    - Hits in 4 XFT Layers
    - XFT Track with pT = 10.11 GeV
  - Level 2 : L2_TRK15_TRKISO30_&_TRK15_D0_v-1
    - SVT Track with 15 GeV
    - XFT pT > 14.77 GeV
    - XFT TRACK_ISO_TYPE = 2
    - XFT $0 < \Delta \phi < 30$
  - Level 3 : L3_TRACK_7_CALISO_v-2
    - 3x3 calorimeter isolation

Momentum Spectrum





Isolated Track Selection

- We only want isolated tracks with high momentum (10+ GeV/c)
  - Extrapolate tracks to CES calorimeter
  - Event Quality Selection
    - Number of vertex = 1
    - Total number of tracks < 250
    - Z vertex < 60 cm
    - Track d0 < 1.0 cm and track Z0 < 60 cm
  - Track Quality
    - Track p and p_T > 0.5
    - COT Stereo and Axial hits >= 30
    - Had/EM > 0.056 (electron veto)
    - Total Energy of target towers (sum of EM and HAD) > 5 GeV/c^2 (muon veto)
  - Isolation Cuts (with graphic)
    - No tracks in a 7x7 EM/HAD block
    - No extra CES clusters in a 7x7 block and Δ R > 0.03
  - Tower Cut
    - Only tracks which enter target towers 1 through 5 – only the central region

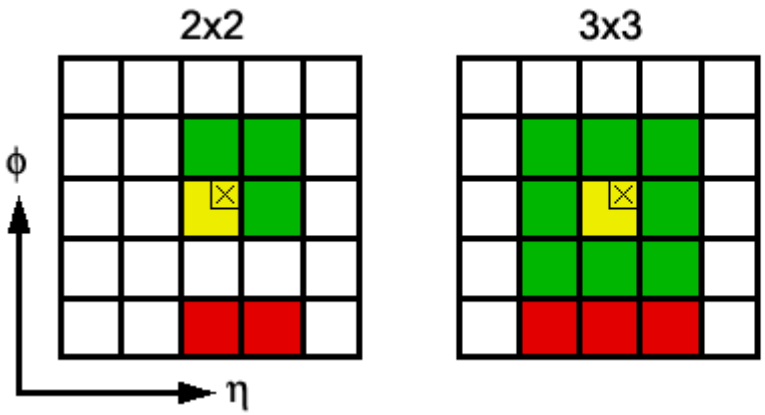
Fake Tracks

- Fake events with two particles generated to compare the data with.
  - 500,000 events generated with v5.3.3
  - Pions, Kaons, and protons generated in a 6:3:1 ratio.
  - Particles and antiparticles were generated evenly.
  - Pythia Tune A minimum bias added as an underlying event.
  - Particles were generated with a flat momentum spectrum.

Comparisons made

- For each track : plot its energy and its energy/momentum in 8 momentum bins: 14, 16, 18, ..., 30 GeV/c: +/-1 GeV/c
- Plot the energy response in the EM and Hadron calorimeters.
  - EM: 2x2 block EM background: 1x2 strip
  - HAD: 3x3 block HAD background: 1x3 strip
  - Background energy is defined as the Nx1 strip furthest away from the extrapolation position
  - See following picture for more details
- In addition, plot the total of the two (EM+HAD) and minimum ionizing particles (MIP)
  - MIP defined a track with EM < 670 MeV/c^2
- Normalize all the plots to unit area to compare data to MC
- Fit each histogram
  - Used “converging” Gaussian fits
  - Fit range is 3σ around mean of previous Gaussian until the fit converges.

Signal and Background Definitions



- Left: EM definition Right: HAD definition
  - Target Tower in yellow
  - Neighboring/Signal towers in green
  - Background towers in Red
  - X marks the track extrapolation position

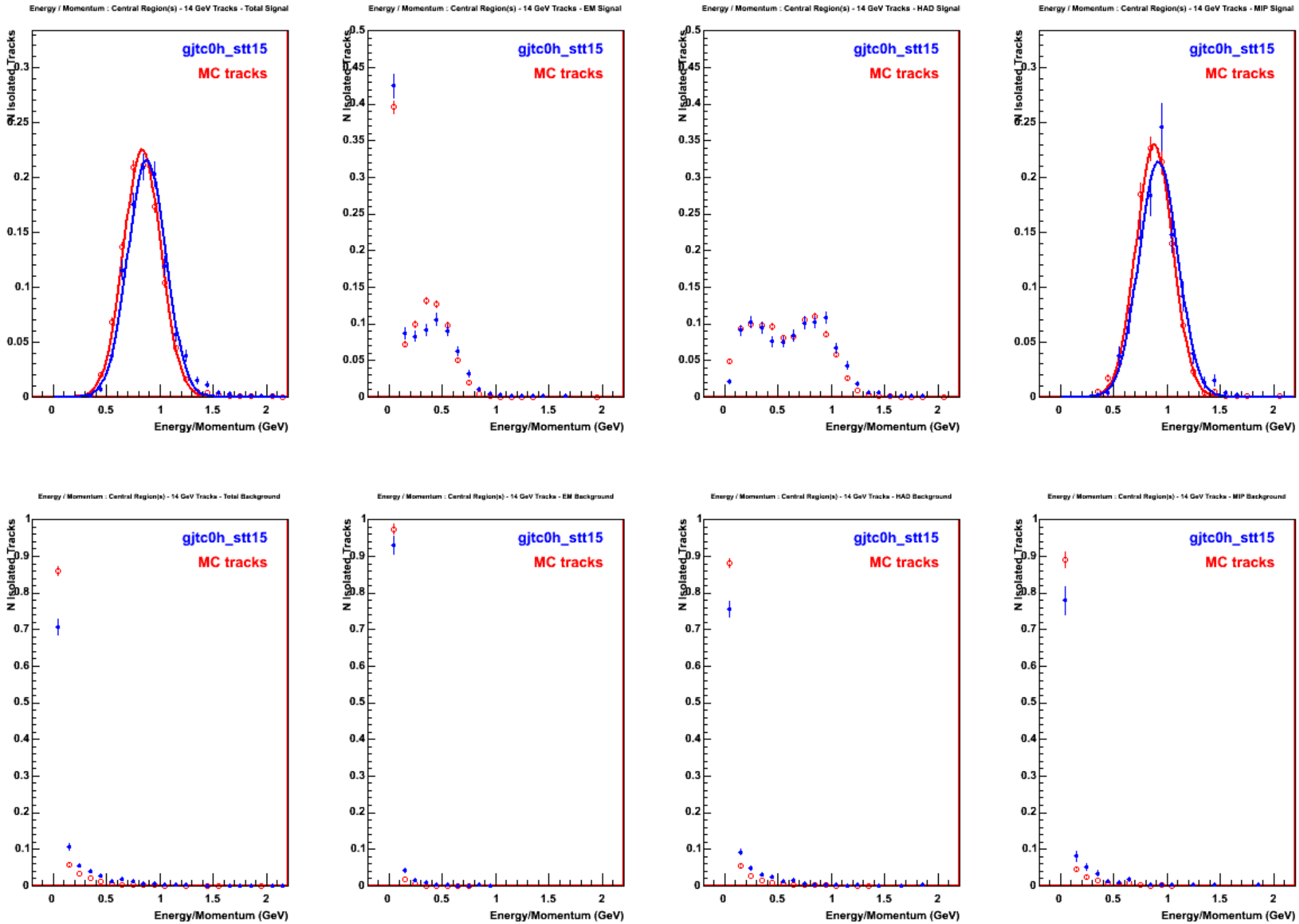
Histogram Layout

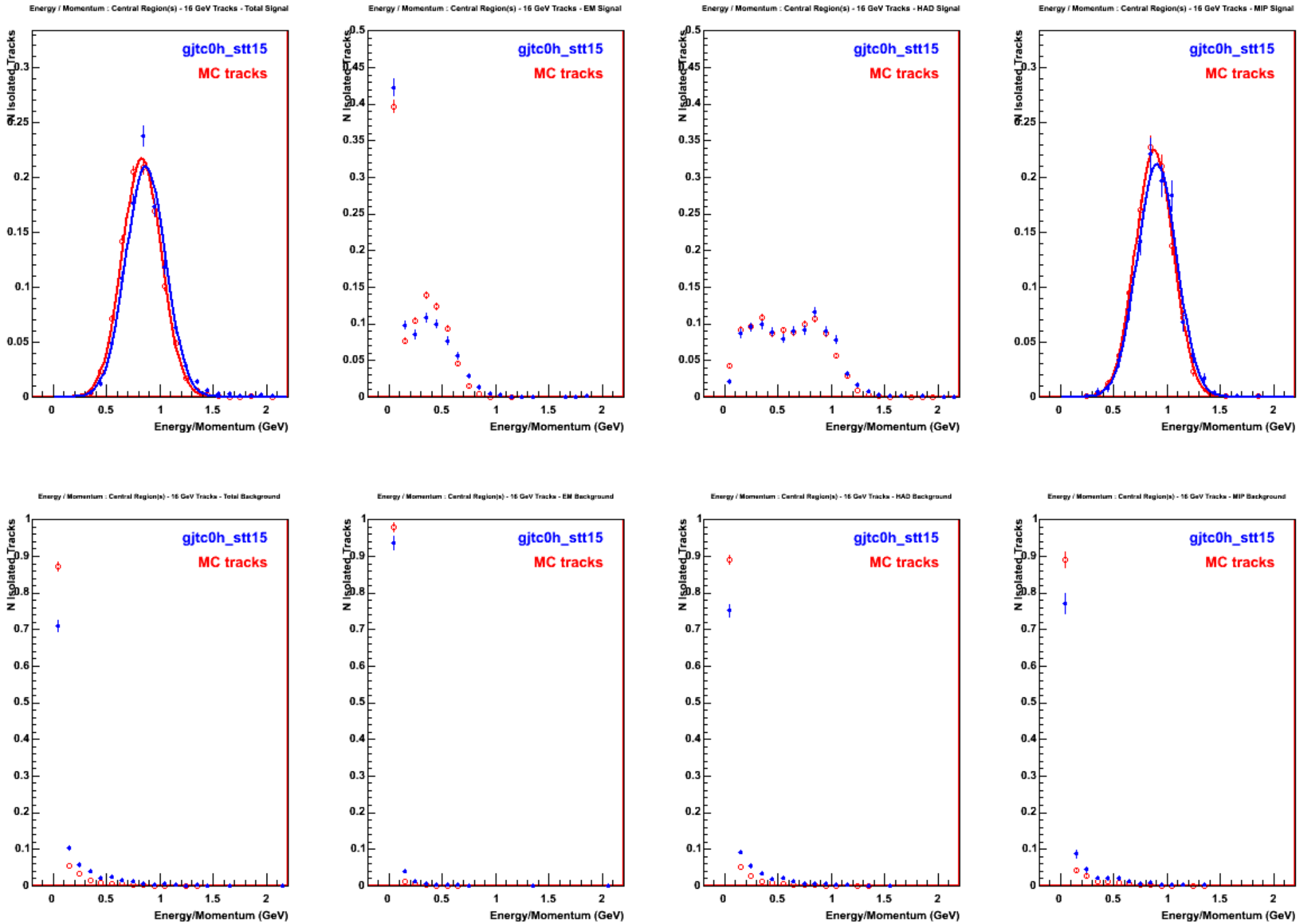
- E/p histogram have the following layout
  - There are four “compartments” each with signal and background
  - Caution: vertical scale is not always the same

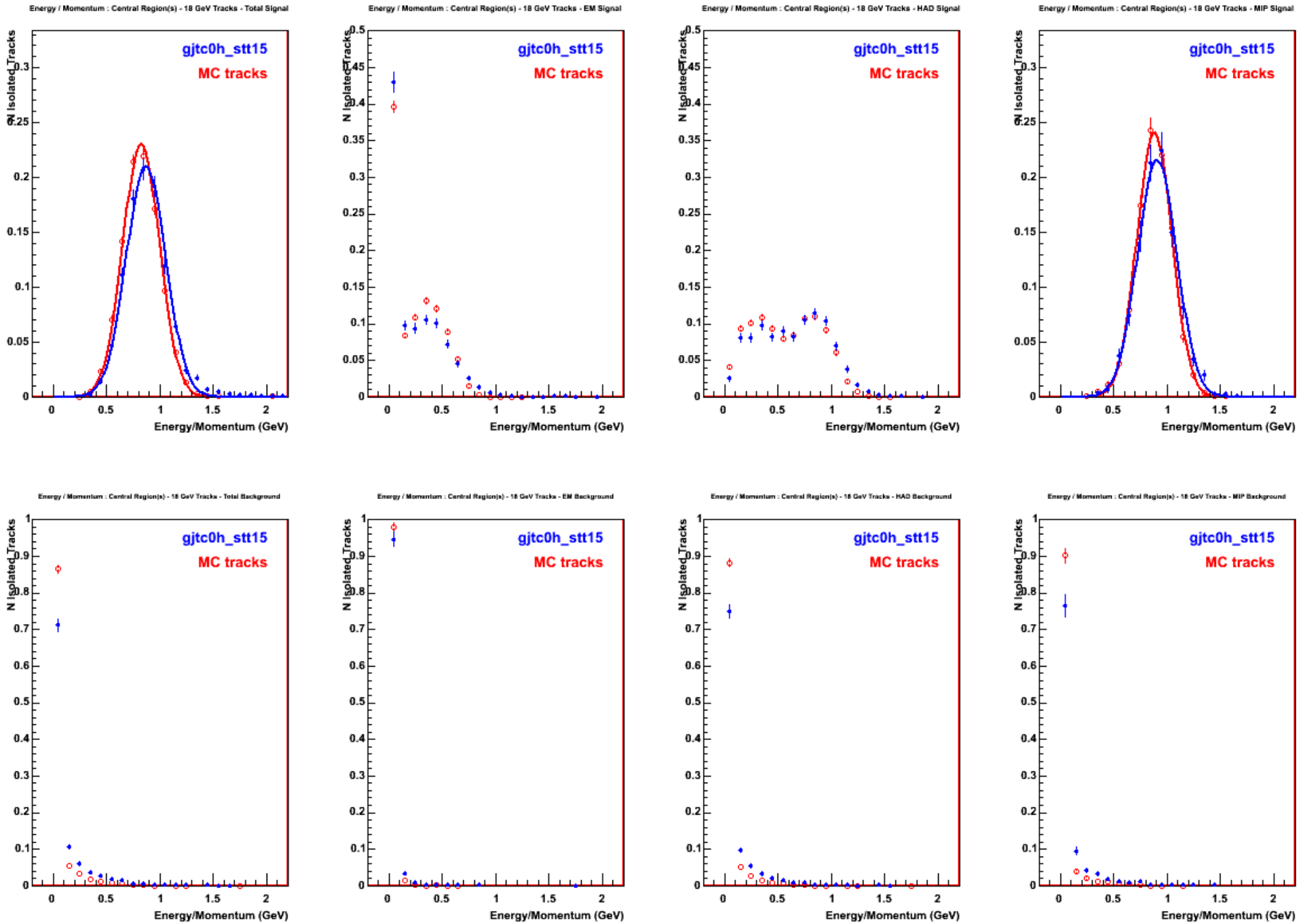
Total Energy Signal	EM Signal	HAD Signal	MIP Signal
Total Energy Background	EM Background	HAD Background	MIP Background

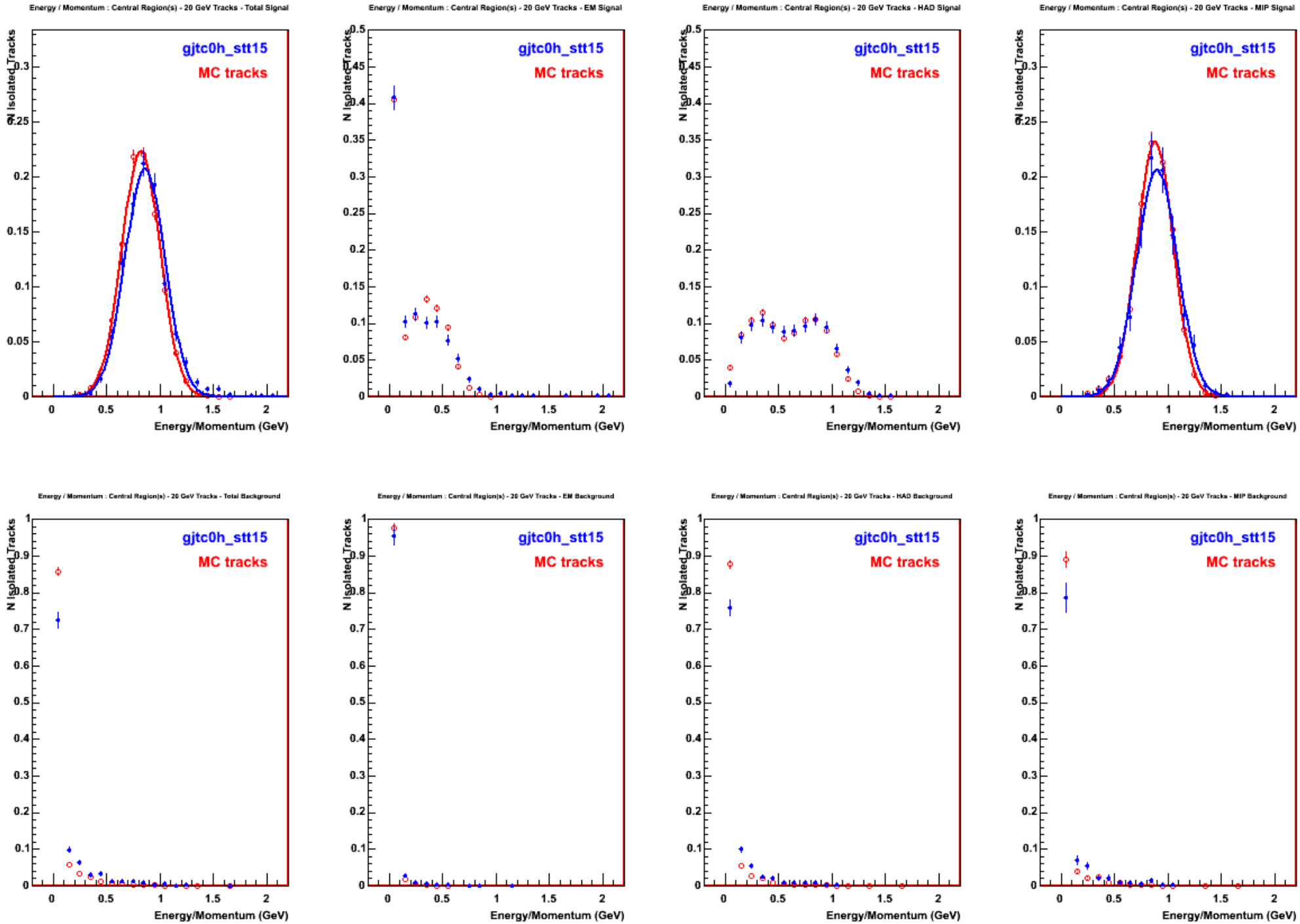
Colors:

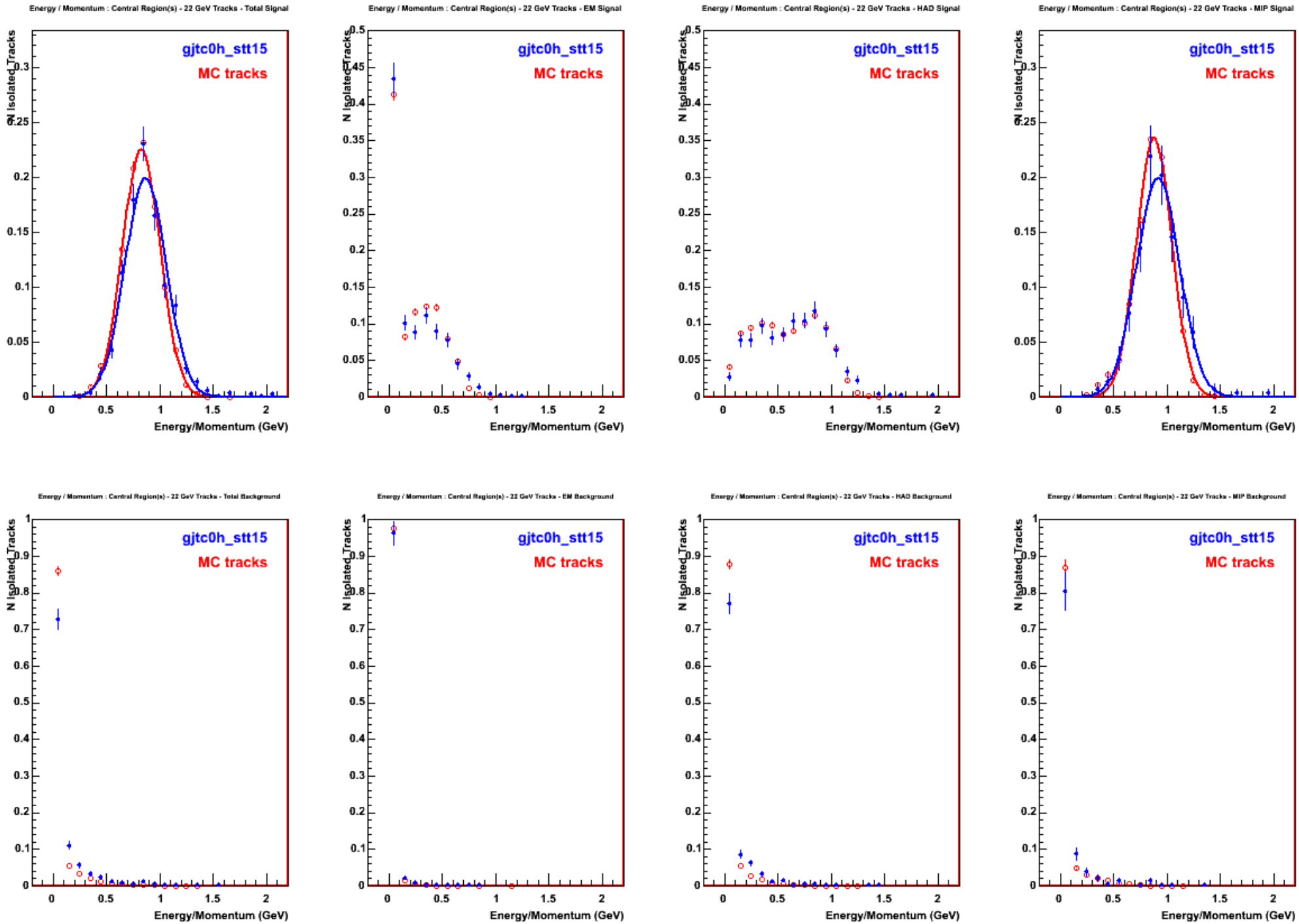
- Single Track Trigger (gjtc0h_stt15) : Blue line and closed circles
- MC Tracks : Red Line and open circles

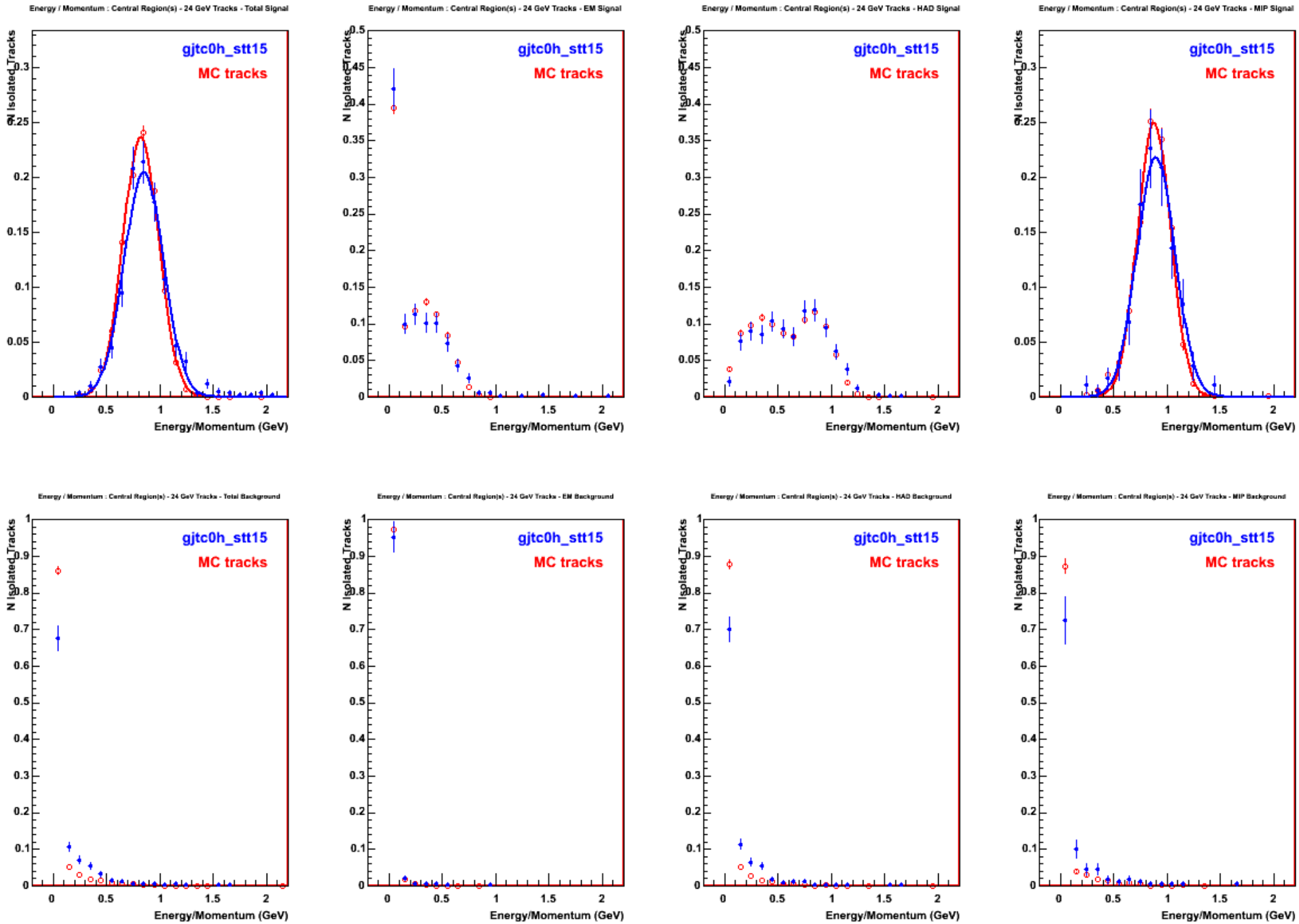

Energy / Momentum : Central Region(s) - 14 GeV Tracks - Total Signal
Energy / Momentum : Central Region(s) - 14 GeV Tracks - EM Signal
Energy / Momentum : Central Region(s) - 14 GeV Tracks - HAD Signal
Energy / Momentum : Central Region(s) - 14 GeV Tracks - MIP Signal
Energy / Momentum : Central Region(s) - 14 GeV Tracks - Total Background
Energy / Momentum : Central Region(s) - 14 GeV Tracks - EM Background
Energy / Momentum : Central Region(s) - 14 GeV Tracks - HAD Background
Energy / Momentum : Central Region(s) - 14 GeV Tracks - MIP Background
gjtc0h_stt15
MC tracks
N Isolated Tracks
Energy/Momentum (GeV)

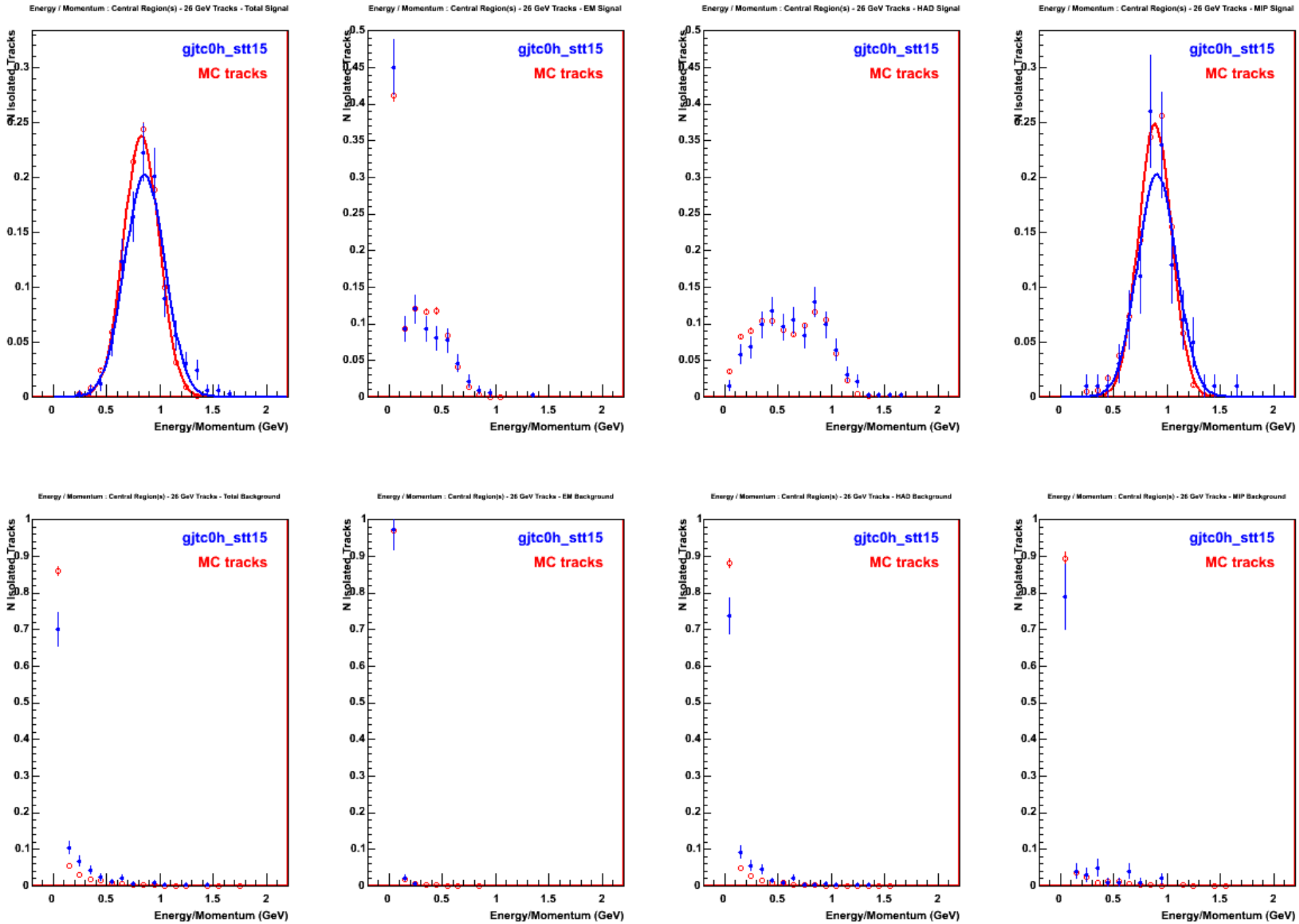

Energy / Momentum : Central Region(s) - 16 GeV Tracks - Total Signal
Energy / Momentum : Central Region(s) - 16 GeV Tracks - EM Signal
Energy / Momentum : Central Region(s) - 16 GeV Tracks - HAD Signal
Energy / Momentum : Central Region(s) - 16 GeV Tracks - MIP Signal
Energy / Momentum : Central Region(s) - 16 GeV Tracks - Total Background
Energy / Momentum : Central Region(s) - 16 GeV Tracks - EM Background
Energy / Momentum : Central Region(s) - 16 GeV Tracks - HAD Background
Energy / Momentum : Central Region(s) - 16 GeV Tracks - MIP Background
gjtc0h_stt15
MC tracks
N Isolated Tracks
Energy/Momentum (GeV)

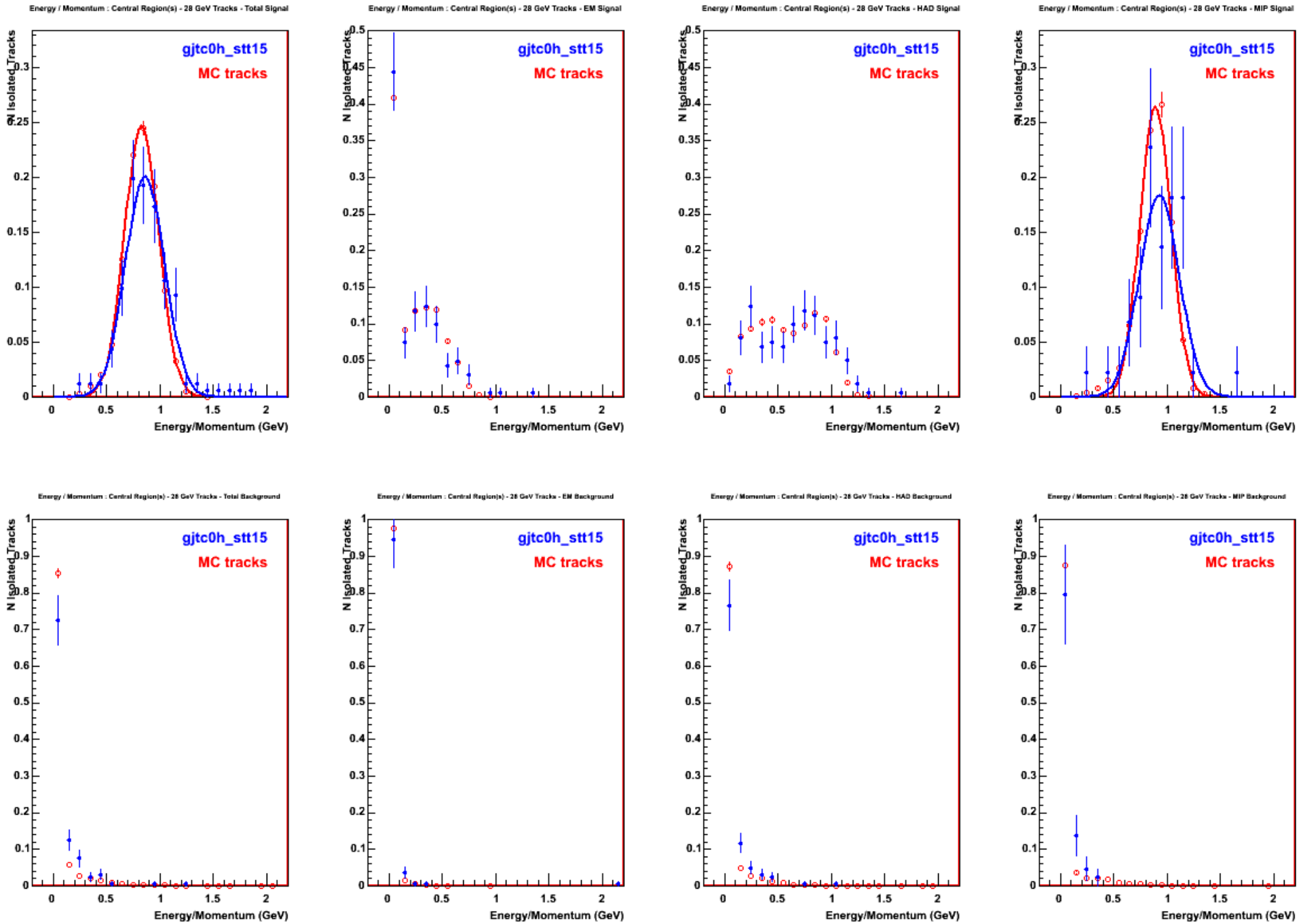

Energy / Momentum : Central Region(s) - 18 GeV Tracks - Total Signal
Energy / Momentum : Central Region(s) - 18 GeV Tracks - EM Signal
Energy / Momentum : Central Region(s) - 18 GeV Tracks - HAD Signal
Energy / Momentum : Central Region(s) - 18 GeV Tracks - MIP Signal
Energy / Momentum : Central Region(s) - 18 GeV Tracks - Total Background
Energy / Momentum : Central Region(s) - 18 GeV Tracks - EM Background
Energy / Momentum : Central Region(s) - 18 GeV Tracks - HAD Background
Energy / Momentum : Central Region(s) - 18 GeV Tracks - MIP Background
gjtc0h_stt15
MC tracks
N Isolated Tracks
Energy/Momentum (GeV)

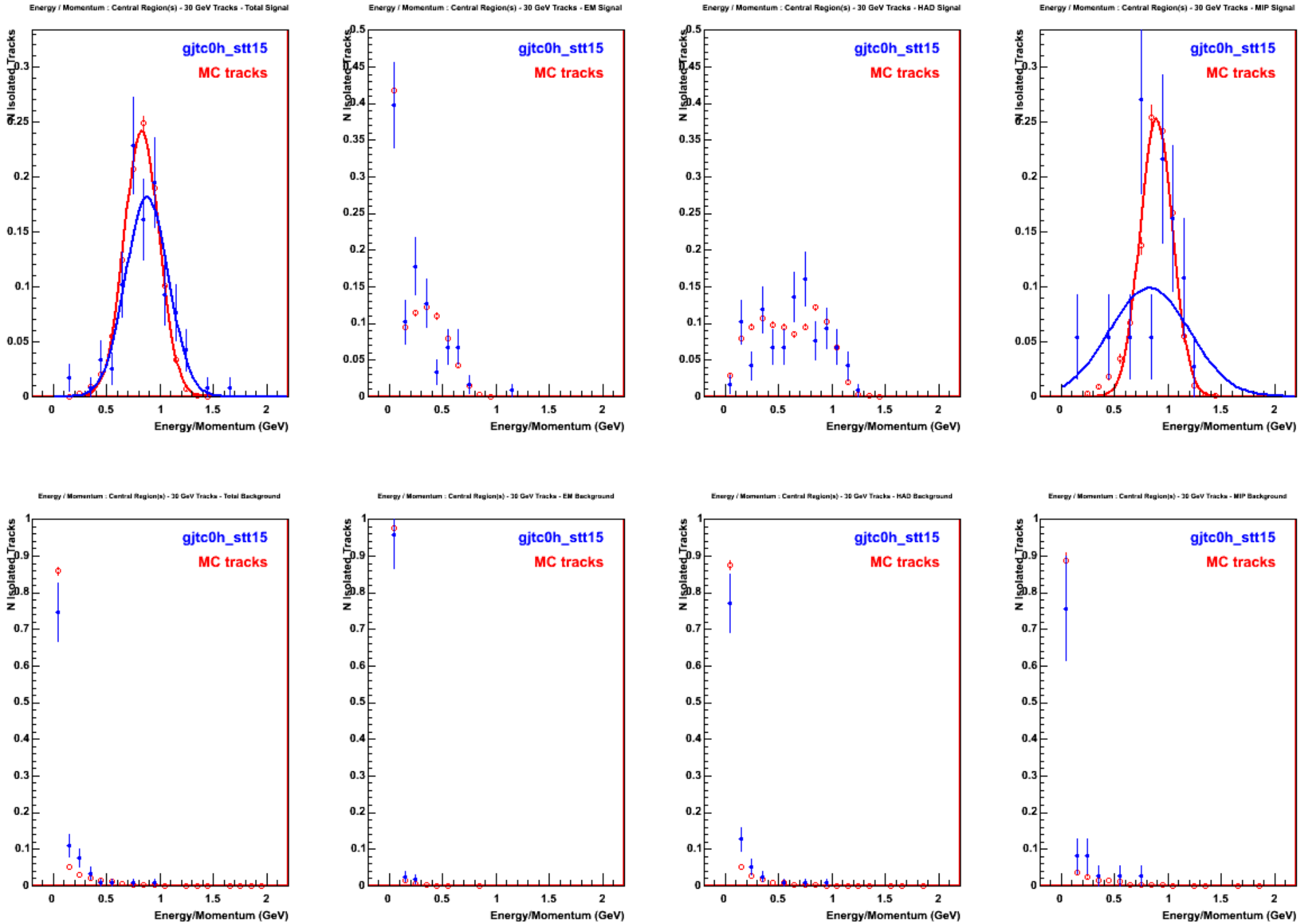

Energy / Momentum : Central Region(s) - 20 GeV Tracks - Total Signal
Energy / Momentum : Central Region(s) - 20 GeV Tracks - EM Signal
Energy / Momentum : Central Region(s) - 20 GeV Tracks - HAD Signal
Energy / Momentum : Central Region(s) - 20 GeV Tracks - MIP Signal
Energy / Momentum : Central Region(s) - 20 GeV Tracks - Total Background
Energy / Momentum : Central Region(s) - 20 GeV Tracks - EM Background
Energy / Momentum : Central Region(s) - 20 GeV Tracks - HAD Background
Energy / Momentum : Central Region(s) - 20 GeV Tracks - MIP Background
gjtc0h_stt15
MC tracks
N Isolated Tracks
Energy/Momentum (GeV)


Energy / Momentum : Central Region(s) - 22 GeV Tracks - Total Signal
Energy / Momentum : Central Region(s) - 22 GeV Tracks - EM Signal
Energy / Momentum : Central Region(s) - 22 GeV Tracks - HAD Signal
Energy / Momentum : Central Region(s) - 22 GeV Tracks - MIP Signal
Energy / Momentum : Central Region(s) - 22 GeV Tracks - Total Background
Energy / Momentum : Central Region(s) - 22 GeV Tracks - EM Background
Energy / Momentum : Central Region(s) - 22 GeV Tracks - HAD Background
Energy / Momentum : Central Region(s) - 22 GeV Tracks - MIP Background
gjtc0h_stt15
MC tracks
N Isolated Tracks
Energy/Momentum (GeV)


Energy / Momentum : Central Region(s) - 24 GeV Tracks - Total Signal
Energy / Momentum : Central Region(s) - 24 GeV Tracks - EM Signal
Energy / Momentum : Central Region(s) - 24 GeV Tracks - HAD Signal
Energy / Momentum : Central Region(s) - 24 GeV Tracks - MIP Signal
Energy / Momentum : Central Region(s) - 24 GeV Tracks - Total Background
Energy / Momentum : Central Region(s) - 24 GeV Tracks - EM Background
Energy / Momentum : Central Region(s) - 24 GeV Tracks - HAD Background
Energy / Momentum : Central Region(s) - 24 GeV Tracks - MIP Background
gjtc0h_stt15
MC tracks
N Isolated Tracks
Energy/Momentum (GeV)


Energy / Momentum : Central Region(s) - 26 GeV Tracks - Total Signal
Energy / Momentum : Central Region(s) - 26 GeV Tracks - EM Signal
Energy / Momentum : Central Region(s) - 26 GeV Tracks - HAD Signal
Energy / Momentum : Central Region(s) - 26 GeV Tracks - MIP Signal
Energy / Momentum : Central Region(s) - 26 GeV Tracks - Total Background
Energy / Momentum : Central Region(s) - 26 GeV Tracks - EM Background
Energy / Momentum : Central Region(s) - 26 GeV Tracks - HAD Background
Energy / Momentum : Central Region(s) - 26 GeV Tracks - MIP Background
gjtc0h_stt15
MC tracks
N Isolated Tracks
Energy/Momentum (GeV)

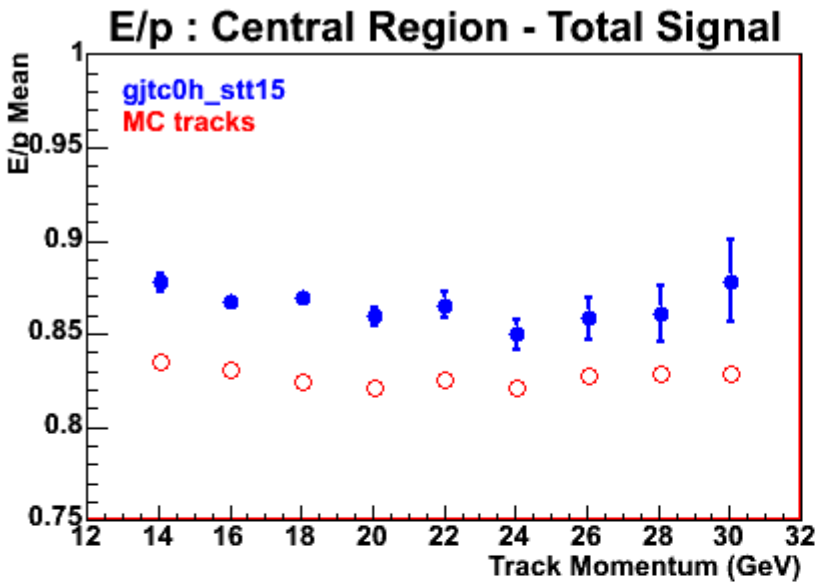

Energy / Momentum : Central Region(s) - 28 GeV Tracks - Total Signal
Energy / Momentum : Central Region(s) - 28 GeV Tracks - EM Signal
Energy / Momentum : Central Region(s) - 28 GeV Tracks - HAD Signal
Energy / Momentum : Central Region(s) - 28 GeV Tracks - MIP Signal
Energy / Momentum : Central Region(s) - 28 GeV Tracks - Total Background
Energy / Momentum : Central Region(s) - 28 GeV Tracks - EM Background
Energy / Momentum : Central Region(s) - 28 GeV Tracks - HAD Background
Energy / Momentum : Central Region(s) - 28 GeV Tracks - MIP Background
gjtc0h_stt15
MC tracks
N Isolated Tracks
Energy/Momentum (GeV)

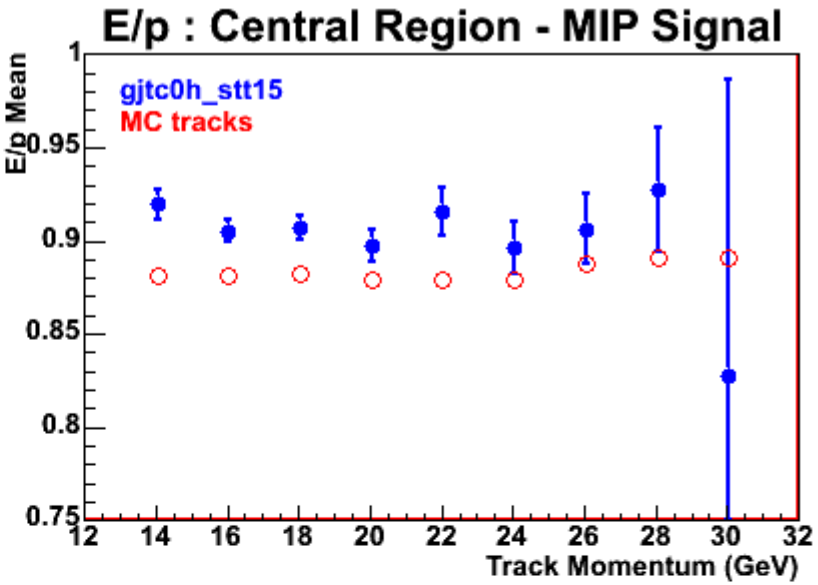

Energy / Momentum : Central Region(s) - 30 GeV Tracks - Total Signal
Energy / Momentum : Central Region(s) - 30 GeV Tracks - EM Signal
Energy / Momentum : Central Region(s) - 30 GeV Tracks - HAD Signal
Energy / Momentum : Central Region(s) - 30 GeV Tracks - MIP Signal
Energy / Momentum : Central Region(s) - 30 GeV Tracks - Total Background
Energy / Momentum : Central Region(s) - 30 GeV Tracks - EM Background
Energy / Momentum : Central Region(s) - 30 GeV Tracks - HAD Background
Energy / Momentum : Central Region(s) - 30 GeV Tracks - MIP Background
gjtc0h_stt15
MC tracks
N Isolated Tracks
Energy/Momentum (GeV)

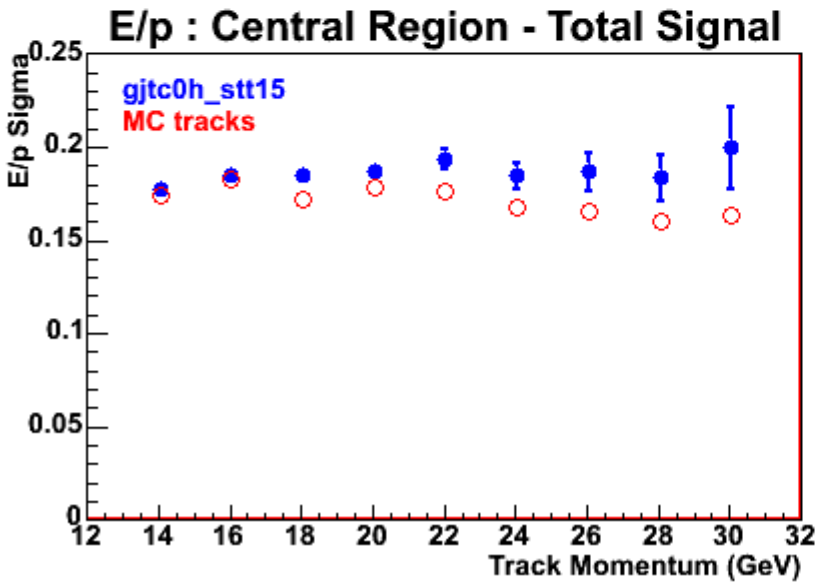
Plots fit results

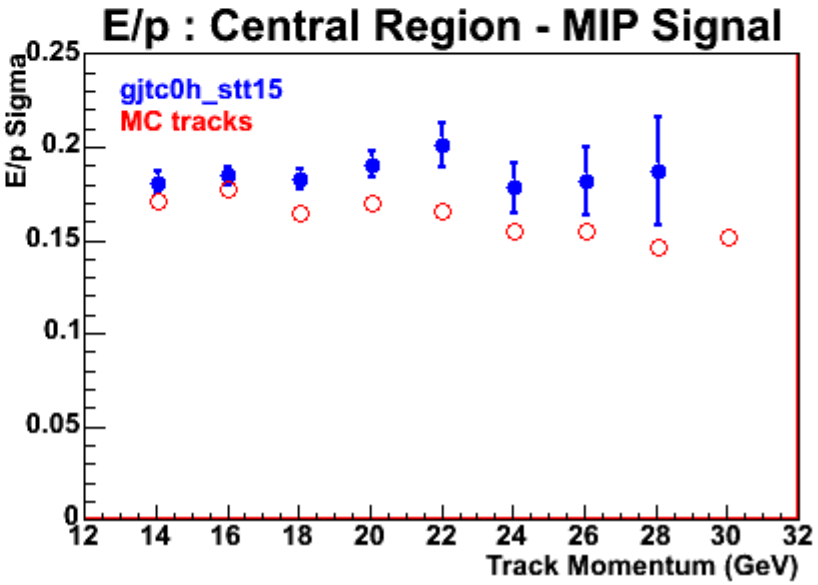
- For each momentum bin, take the mean and sigma of the Gaussian fit.
- Plot the mean and sigma for the Total and MIP signals as a function of the momentum bins.
- Plot the ratio Q=1-MC/Data

Mean and Sigma from Fits

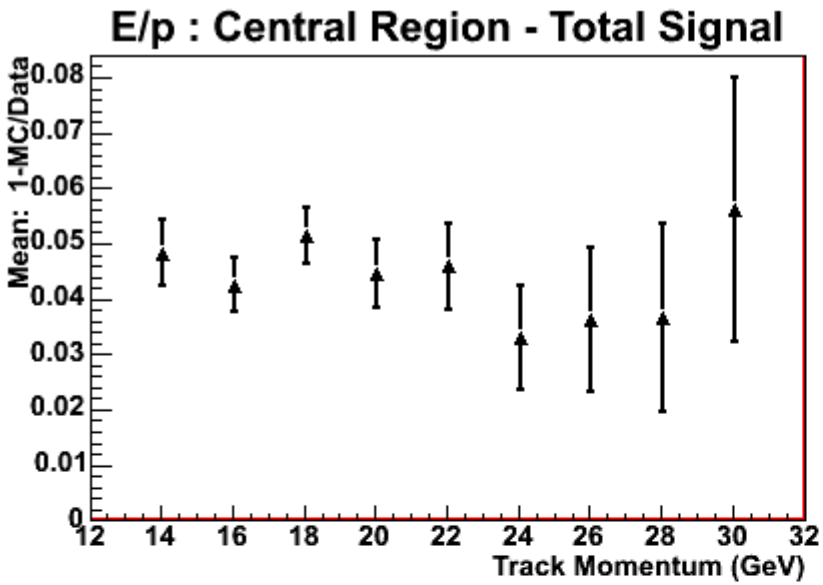


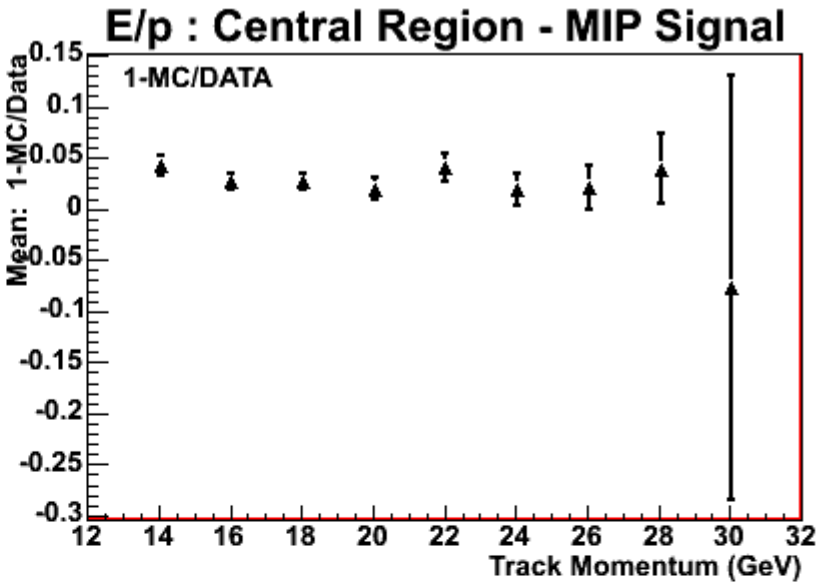


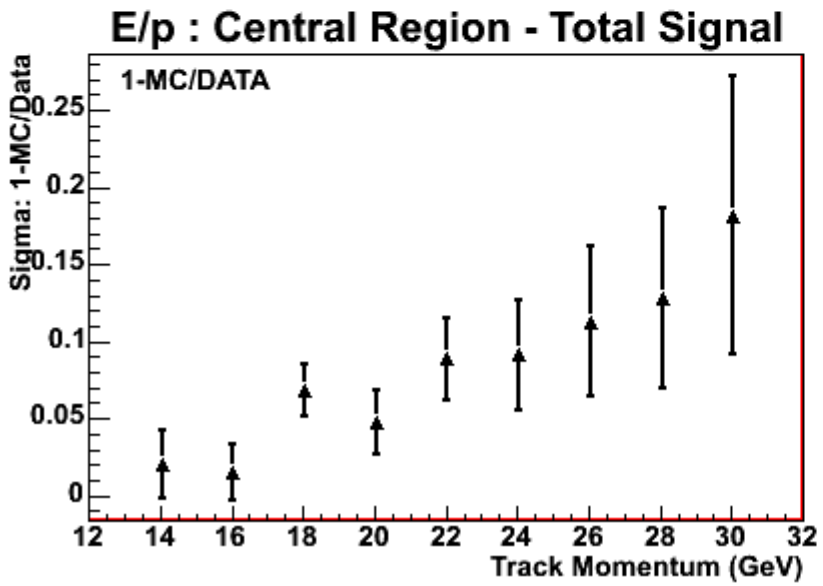


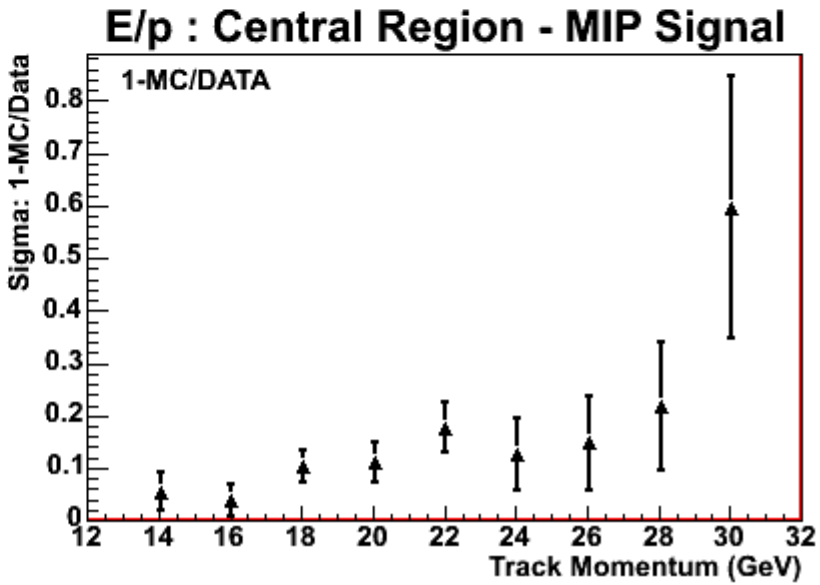


Plot of Q=1-MC/Data







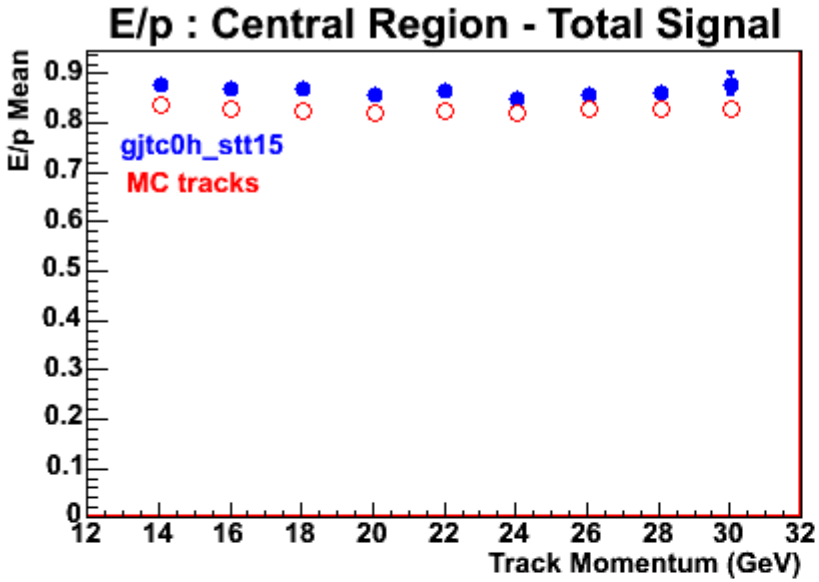


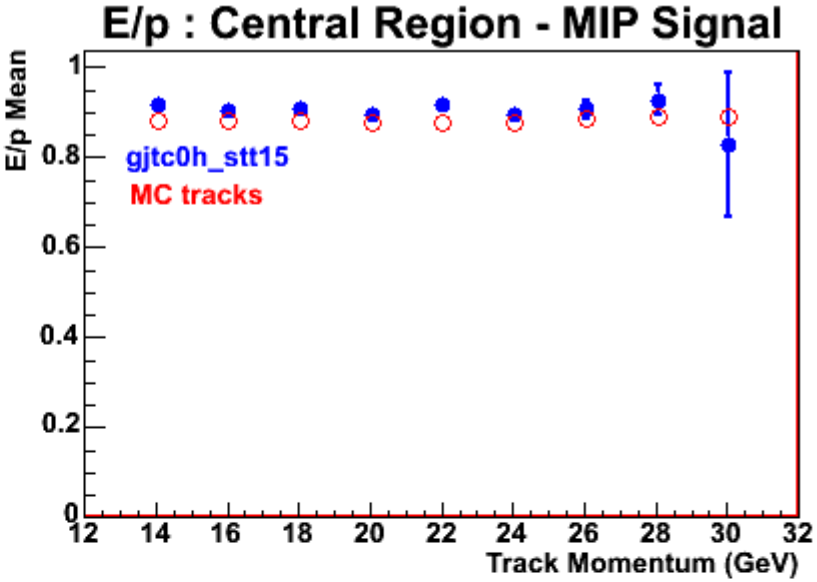
Conclusion

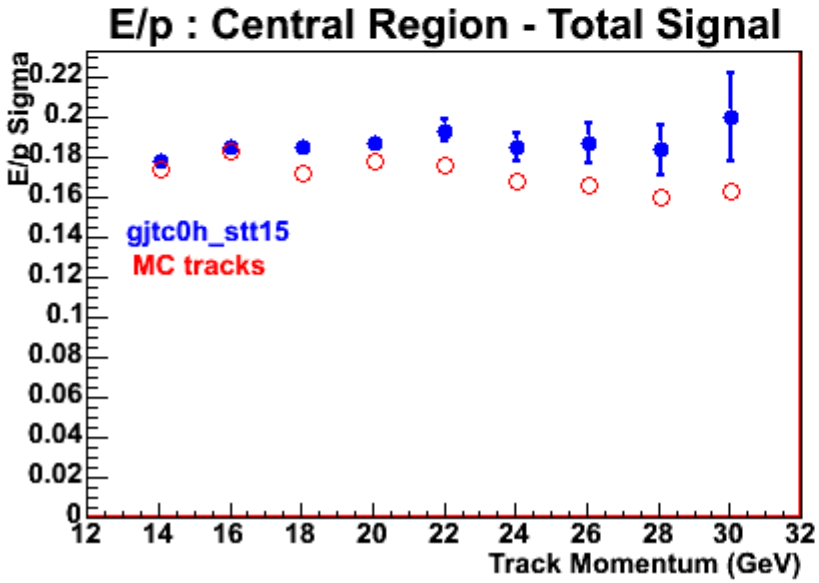
- Reasonable agreement between STT data and MC for high momentum tracks.
  - About a 5% different between MC and STT data for tracks up to 28 GeV/c.
  - Highest momentum bin (30 GeV/c) has larger discrepancy but more statistics should help
- For the Future
  - We are processing the rest of the single track trigger data now.
  - Generate MC tracks using current development version to take advantage of Pedreo's lateral turning.
  - Momentum weight the MC tracks to STT data.

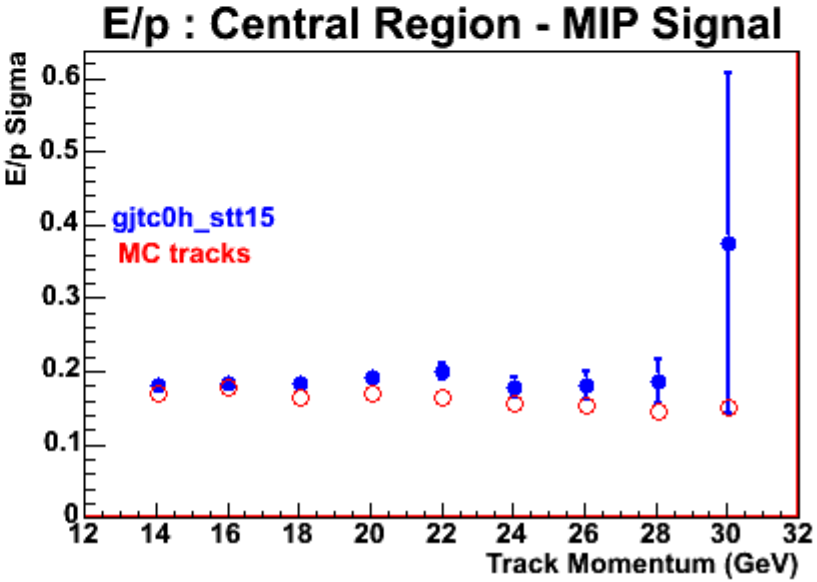
Appendix/Backup

- Mean and Sigma plots with different y-axis.
- All plots, including just Energy Distribution, are available at: http://www-cdf.fnal.gov/~skwang/JetCorrections/2005-1102_Canvase
- Look for AllPlots.pdf/ps


E/p : Central Region - Total Signal
E/p Mean
gjtc0h_stt15
MC tracks
Track Momentum (GeV)


E/p : Central Region - MIP Signal
E/p Mean
gjtc0h_stt15
MC tracks
Track Momentum (GeV)


E/p : Central Region - Total Signal
E/p Sigma
gjtc0h_stt15
MC tracks
Track Momentum (GeV)


E/p : Central Region - MIP Signal
E/p Sigma
gjtc0h_stt15
MC tracks
Track Momentum (GeV)